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Policy issues for science, technology and innovation: leveraging technology and trade for economic development

Leveraging technology and trade for economic development

Note by the secretariat

Summary

Technological progress and trade are inextricably linked. Global trade has accelerated the spread of innovation and technology, and technological advances – particularly in the areas of information and communication, transport, and electronic commerce and payment – have spurred international trade.

Technology continues to reshape international trade today, affecting not only what goods and services are traded but also the way in which they are traded. Electronic commerce and paperless trade are just two examples of how technology is changing the way in which trade has traditionally been conducted.

Trade, technology and industrial policies all affect the development of particular sectors and industries, and therefore directly or indirectly influence technological learning and progress. Historically, these policies have helped a few countries in the region to catch up. While policies today still play an important role in economic development and technological upgrading, certain measures that affect trade by protecting domestic markets or promoting exports are prohibited or restricted under multilateral trade agreements.

The Committee on Information and Communications Technology, Science, Technology and Innovation is invited to reflect on the opportunities and challenges related to the leveraging of technology and trade for economic development by sharing experiences and lessons learned in these areas. Furthermore, the Committee is invited to identify policy priorities and focus areas for regional cooperation to guide the work of the secretariat.

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I. Introduction

1. Technology is a key factor that drives productivity growth and global market competition and defines global value chains. Technological innovation spawns new businesses and shapes the nature of international competition and international trade.

2. For many developing countries, such technological dynamism brings both opportunities and challenges. The Internet and smartphones have enabled the dissemination of information at an unprecedented scale and pace. Today, it is possible for firms and entrepreneurs to discover news or information about the most advanced technologies directly online. New ways of doing business, such as electronic commerce, enable individuals and small and medium-sized enterprises to participate more easily in international trade.

3. On the other hand, technology gaps between countries that are leading in the region and those that are lagging behind still exist or have been widening, making it difficult for some countries to climb up the global value chains, diversify exports and catch up with developed countries.

4. Policy intervention is critical in stimulating economic growth and technological progress for the countries in the region. The examples of a few Asia-Pacific countries having successfully caught up over the past several decades – the so-called East Asian miracle[1] – show that policy intervention can effectively gear economic development.

5. The environment for policymaking, however, is different from several decades ago. For example, free trade agreements impose restrictions on implementing certain types of policy measures. Any industrial and technology policy today needs to be compatible with trade rules. Furthermore, while the rapid development of digital and frontier technologies provides new business opportunities, many countries may find it difficult to keep the same pace in making and adapting laws and regulations to address the issues related to these technologies.

6. This document contains a review of the interplay and dynamism between trade and technology. Production technologies largely define what countries can produce and export. This process is dynamic because technological learning and upgrading take place in all countries, thus reshaping production and international trade. In this document, the emphasis is on issues on policies related to industry, trade, and science, technology and innovation in enhancing technological upgrading and innovation.

II. Production technology dictates what a country can produce and export

A. Production technology largely decides the structure of trade and global value chains

7. What a country produces or can produce is often defined by its endowment of physical and human capital, labour and natural resources, along with the overall quality of its institutions. For instance, mango grows in South-East Asian countries, where the soil and tropical climate are favourable for its

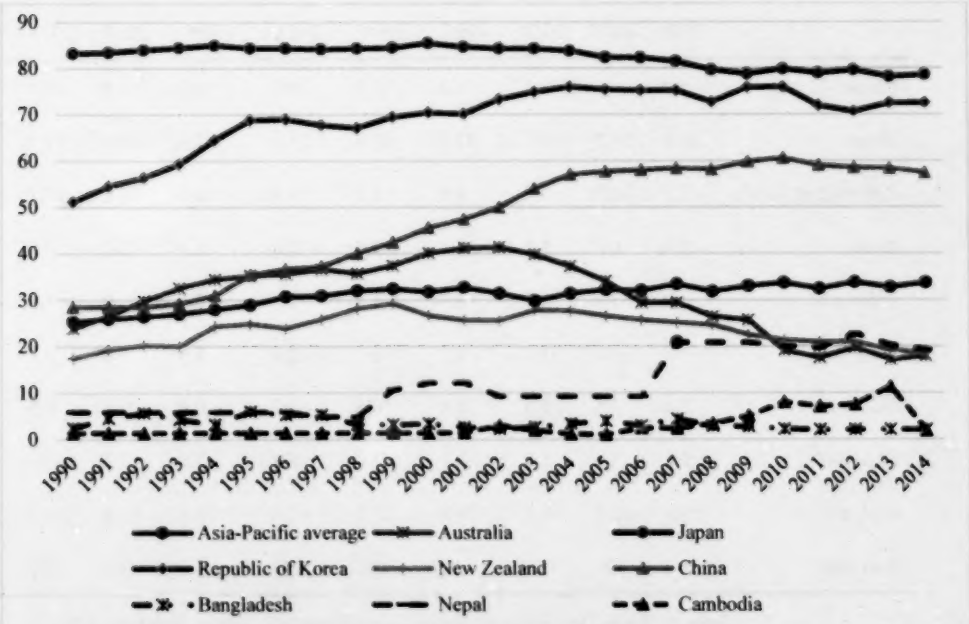
[1] World Bank, *The East Asian Miracle: Economic Growth and Public Policy – Main Report* (Oxford University Press, New York, 1993).

growth or a small island country may find it easier to develop tourism over heavy industry.

8. When products such as textiles and clothing are produced by many countries, cross-country differences in technology often explain the international pattern of specialization and trade because technology can play a vital role in the quality and costs of the final products. Technology gaps can also influence the type of goods exported. More advanced countries typically produce and export more technologically sophisticated goods. Technological upgrading takes place in every country worldwide at different speeds.

9. The evolution of exports in Asia-Pacific countries provides evidence for the above observations. Figure I shows that between 1990 and 2014, medium-high- and high-technology manufactured exports from Asia-Pacific countries on average increased from 24 to 34 per cent. During the same period, medium-high- and high-technology manufactured exports from Japan accounted for approximately 80 per cent of the country's total manufactured exports, while their share increased from 51 to 72 per cent in the Republic of Korea and from 28 to 57 per cent in China.

Figure I
Share of medium-high- and high-technology manufactured exports in total manufactured exports, Asia-Pacific countries, 1990–2014
(Percentage)



Source: Calculations by the Economic and Social Commission for Asia and the Pacific (ESCAP) based on United Nations Industrial Development Organization (UNIDO), "Medium and high-tech exports (% manufactured exports)", Competitive Industrial Performance database. Available at https://data.worldbank.org/indicator/TX.MNF.TECH.ZS.UN (accessed 20 June 2018).

Note: UNIDO uses a taxonomy of industry groups by technological intensity: (a) medium-high and high technology; (b) medium technology; and (c) low technology. For more information, see http://stat.unido.org/content/focus/classification-of-manufacturing-sectors-by-technological-intensity-%2528isic-revision-4%2529;jsessionid=F033873E486B87E001C2B35638A0793D.

10. Figure I also shows that in the three least developed countries from the region – Bangladesh, Cambodia and Nepal – the rate of medium-high- and high-technology manufactured exports is generally low. However, in Nepal, the share has substantially improved over time, having increased from 6 to 19 per cent between 1990 and 2014.[2] Interestingly, in two advanced economies in the region – Australia and New Zealand – there is a generally low rate of medium-high- and high-technology manufactured exports. This can be explained by natural endowment: the main exported goods from Australia and New Zealand are minerals and agricultural products respectively, which both belong to low-technology sectors.

11. The development of the manufacturing industry in China has had a substantial impact on the trade structure. As shown in table 1, in 1996, China, the Republic of Korea and Thailand exported the greatest percentage of low-technology products in the region, while Japan exported 30 per cent of high-technology products. By 2014, China exported the greatest percentage of high-technology products in the region, with a market share of 43.7 per cent.

Table 1
Share in Asia's manufactured goods exports against Asia's total manufactured exports
(Percentage)

	High technology			*Medium-high technology*			*Medium-low technology*			*Low technology*		
	1996	*2000*	*2014*	*1996*	*2000*	*2014*	*1996*	*2000*	*2014*	*1996*	*2000*	*2014*
China	5.9	9.4	43.7	6.3	10.1	36.5	10.8	14.9	34.6	21.2	26.3	55.4
Japan	30.0	25.5	7.7	52.8	49.8	23.6	27.6	24.7	11.1	5.4	5.1	2.0
Republic of Korea	7.3	10.7	9.4	9.9	9.7	14.4	15.4	16.2	15.1	7.6	6.7	2.4
India	0.4	0.3	1.7	1.1	1.2	3.6	1.9	2.5	9.6	6.0	6.7	9.4
Indonesia	0.9	1.4	0.5	0.9	1.4	1.7	2.6	3.0	1.8	6.1	5.9	5.2
Malaysia	9.4	9.7	4.7	2.2	2.1	2.4	3.5	3.6	4.2	4.5	3.4	3.2
Philippines	2.6	4.5	1.6	0.4	0.6	0.7	0.8	0.8	0.5	1.7	1.5	0.9
Thailand	3.8	3.6	2.7	2.1	3.0	5.2	2.5	3.2	3.6	6.5	5.5	4.3
Rest of Asia	39.8	35.0	28.0	24.3	22.2	11.8	35.1	31.1	19.5	41.0	39.1	17.1
Asia total	100	100	100	100	100	100	100	100	100	100	100	100

Source: Asian Development Bank, *Asian Economic Integration Report 2015: How Can Special Economic Zones Catalyze Economic Development?* (Manila, 2015).

12. While the share of high-technology export goods is an important indicator of a country's technology capacity, there are two important points to note. First, global value chains mean a country may actually assemble a high-technology product and work on low-technology activities with low value

[2] This may be explained by the fact that Nepal began implementing a structural adjustment programme in the mid-1980s with the support of the International Monetary Fund and the World Bank. For further details, see Prakash Kumar Shrestha, "Structural changes and economic growth in Nepal", 19 October 2010.

added. In this case, the country may not really own the high technology, although the final export product is counted in the high-technology exports of a country, which adds little value to total exports. Second, a low-technology product does not necessarily mean a low level of innovation. For example, technology fusion[3] – the combination of already existing technologies or engineering and science disciplines into new hybrids that are greater than the sum of their parts – can lead to innovation.[4]

13. In the future, new advanced technologies such as artificial intelligence and robotics may further reshape international trade patterns. It is possible that the flow of foreign direct investment may be reduced if foreign companies build factories in their home countries. Similarly, reshoring may occur, whereby foreign companies move their operations from developing countries back to their home countries. Evidence in this respect is scarce, probably because many new frontier technologies are still at the nascent stage of development and have yet to achieve widespread application. Nevertheless, it is important to monitor developments in this respect.

B. Trade can stimulate the diffusion of production technology

14. The international competition brought about by trade can have either positive or negative impacts on technology development. Trade can exert a market-pull effect on technology and innovation. In order to compete in the international market, producers have to be competitive in at least one area, such as low costs or high quality of products. A potential solution is through technological upgrading. Often, this means that producers need to be innovative or able to adopt appropriate technology. On the other hand, when an economy is open to trade, foreign products may crowd local producers out of the market. In some cases, import products may have a hugely adverse impact on local industry such as manufacturing or infant industries. The resulting deindustrialization may limit the opportunities of countries to understand and develop technologies.

15. Global value chains can contribute to technology diffusion. The local firms that participate in global value chains may directly receive the technologies. Furthermore, participating in global value chains can generate spillovers for other firms: there is always some leakage of technology or people, and some of the benefits are also felt by other firms. Such spillovers resulting from technology diffusion in the context of global value chains may happen backwards or forwards. Backward spillovers occur if there is a significant technology upgrading effect for suppliers when one of their clients receives foreign investment: the recipient firm's demand pattern changes, perhaps focusing more on the high-standard merchandise required by its foreign partner, and so the supplier needs to upgrade production to meet that demand.

16. For some specific technologies, a country may have a choice as to whether to develop its own or rely upon foreign technologies. Developing a technology – whether globally new or relatively new to a particular country – can be costly, time-consuming and risky. Hence, it may be more efficient for developing countries to acquire available foreign technologies, especially if the

[3] An example in mechatronics is Fanuc, a spin-off of Fujitsu that combined electronic and mechanical technologies to make computer controls for machine tools and industrial robots and become one of the most profitable companies in Japan. See Fumio Kodama, "Technology fusion and the new R&D", *Harvard Business Review*, July–August 1992.

[4] Lewis M. Branscomb, "Does America need a technology policy?", *Harvard Business Review*, March–April 1992.

technologies are easy to diffuse and adopt. In this way, a technologically underdeveloped country could catch up rapidly by absorbing the most advanced technologies.

17. On the other hand, there are several issues associated with reliance on foreign technologies. First, some foreign technologies are simply not for sale, especially if a technology is decisive for the core competitiveness of a company or a country. Second, in some cases, to maintain their competitiveness, multinational corporations may actually provide developing countries with the old generation of technologies. Third, in the case of technology import, the local firms may not be provided with full information about the technologies, therefore making any further innovation or adjustment difficult.

18. For a country or firm, reliance on foreign technology without its own innovation means being a follower of technology, and leapfrogging is prevented. Depending on the national strategy, if a country or firm aims to lead technology internationally, indigenous innovation – based on its own research and development capacity – is essential.

III. Technology underpins the evolution of international trade

A. Transport, information, communication and new technologies stimulate international trade

19. Historically, the development of transport and information and communications technology (ICT) has shaped trade. Today, over 80 per cent of global trade by volume and more than 70 per cent of its value is carried on board ships and handled by seaports worldwide.[5] In this sense, the importance of maritime transport for trade and development cannot be overemphasized.

20. Communication technologies such as the telephone and telegraph made it faster to negotiate and conclude trade deals than using the traditional postal service. Since the 1970s, electronic data interchange has been introduced to facilitate business communication, using electronic means instead of paper.

21. Technology continues to shape trade procedures and state-of-the-art technologies are being adopted. For instance, in the Republic of Korea, the customs service has recently started a pilot project on blockchains for import procedures.[6]

22. Digital technologies are rapidly changing what is tradable. Data are to this century what oil was to the last: a driver of growth and change. Flows of data have created new infrastructure, new businesses, new monopolies, new politics and – crucially – new economics.[7]

23. Information technology is being used to enhance tourism services such as travel bookings, planning of itineraries, marketing of destinations and information-sharing. With the rapid development of the Internet, smartphones, and fourth- and fifth-generation wireless systems, more media products, such as films, videos, music and audio recordings, radio broadcasts and video games, are becoming tradable. For example, the streaming company Netflix is

[5] *Review of Maritime Transport 2017* (United Nations publication, Sales No. E.17.II.D.10).

[6] Samburaj Das, "Korea Customs Service to pilot blockchain-based import customs platform", CCN, 6 June 2018.

[7] The Economist, "Data is giving rise to a new economy", 6 May 2017.

reported to be one of the most valuable media companies in the world, with a market value of $152.6 billion on 24 May 2018, and the company revealed that its current membership level was 125 million subscribers at the end of first quarter of 2018.[8]

B. Paperless trade and electronic commerce

24. Among numerous technologies that facilitate the conduct of international trade, as discussed above, paperless trade facilitation and electronic commerce are specifically reviewed here given their relevance to the countries in the region.

1. Paperless trade facilitation

25. Paperless trade generally comprises the implementation of innovative and technology-driven measures aimed at enabling trade using electronic rather than paper-based data and documentation. Customs automation systems and national single windows are widely cited examples of paperless trade. A survey conducted by the secretariat on trade facilitation and paperless trade, covering 44 countries in Asia and the Pacific, shows that electronic/automated customs systems are available in most of the countries surveyed (41 of 44) and have been fully implemented in more than half.[9] Challenges remain for implementing electronic single-window systems, which have been implemented fully, partially or on a pilot basis in 23 countries, or more than 50 per cent of all the Asia-Pacific countries surveyed.

26. Cross-border paperless trade refers to trade in goods, including their import, export and transit and related services, that takes place on the basis of electronic communications, including the exchange of trade-related data and documents in electronic form. The survey results show that there has been limited electronic exchange of trade-related data among countries, and often on a pilot basis only.

27. Achieving cross-border paperless trade across the region is expected to be a long and difficult process, which cannot be achieved without close collaboration between countries. To enhance cross-border paperless trade, on 19 May 2016, the Commission, at its seventy-second session, adopted the Framework Agreement on Facilitation of Cross-border Paperless Trade in Asia and the Pacific. Subsequently, five countries in the region – Armenia, Bangladesh, Cambodia, China and the Islamic Republic of Iran – signed the Framework Agreement in 2017, while Azerbaijan acceded to it in March 2018. The secretariat estimated that full implementation of the Framework Agreement would achieve estimated cuts in regional trade costs of 25 per cent on average. Furthermore, estimates show that potential annual export gains associated with moving from manual paper-based trade to paperless trade are estimated to be $257 billion in the region.[10]

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[8] Tae Kim, "Netflix briefly tops Disney as the biggest pure media company in the world by market value", CNBC, 24 May 2018.

[9] The survey was led by the secretariat, with the participation of all the regional commissions and other partners. For detailed information, see https://unnext.unescap.org/content/un-global-survey-trade-facilitation-and-paperless-trade-implementation-2017.

[10] *Digital Trade Facilitation in Asia and the Pacific* (United Nations Publication, Sales No. E.18.II.F.10).

2. Electronic commerce

28. E-commerce refers to the sale and purchase of goods and services through electronic networks and the Internet. There are four main types of e-commerce: business-to-business, business-to-consumer, consumer-to-consumer and, to a lesser extent, business-to-Government.[11]

29. Available data show the importance of e-commerce for international trade. The United Nations Conference on Trade and Development (UNCTAD) estimates that the value of global e-commerce was $25 trillion in 2015, compared with $16.1 trillion in 2013. The United States of America is by far the largest market for e-commerce, with combined sales equalling more than $7 trillion in 2015, while China has the largest business-to-consumer market in the world. In China, e-commerce accounted for 18 per cent of its gross domestic product.[12]

30. E-commerce can promote inclusive development. Compared with traditional trade, e-commerce helps local businesses – especially micro- and small enterprises – individual persons, women entrepreneurs and farmers to reach a broader domestic or international market. E-commerce, in particular cross-border e-commerce, may also bring competition to local markets. A recent study points out that retail in general and e-commerce in particular are thin-margin businesses.[13] Adaptation to e-commerce is not automatic, however, and traditional bricks-and-mortar retailers may struggle to cope with the fierce competition that it brings.

31. Cross-border e-commerce brings new challenges to border agencies such as customs in many countries. The functions of border agencies have traditionally been designed to handle bulky cargo. E-commerce means the cargo arrives in a large number of small parcels: in practice, it is almost impossible to physically check every parcel, meaning that some illegal goods may be shipped to a country in disguise.[14] Second, the small parcels may involve questions with regard to tax. In many countries, the *de minimis* rule means that cargo can be exempted from tax if its value is under a threshold requirement. In theory, traders can exploit this rule by shipping multiple parcels instead of a single one to avoid tax. For instance, purchases from foreign e-commerce vendors outside of Thailand are subject to 7 per cent value added tax only if the value exceeds 1,500 baht, but some online operators exploit the loophole by breaking up invoices into amounts below the threshold to skirt the levy.[15]

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[11] *Asia-Pacific Trade and Investment Report 2016: Recent Trends and Developments* (United Nations publication, Sales No. E.16.II.F.23).

[12] UNCTAD, "Ministers to discuss opportunities and challenges of e-commerce with Jack Ma, eBay, Jumia, Huawei, Etsy, PayPal, Vodafone and more", 21 April 2017.

[13] Sunil Gupta and Tanya Bijlani, "E-commerce in Asia: challenges and opportunities", *Asia Business Insights* (2012).

[14] Michael Morantz, "The dark side of the digital economy: bad things come in small packages", OECD Insights, 18 May 2018.

[15] Bangkok Post, "E-business tax primed for scrutiny", 7 March 2018.

IV. Formulating effective and coherent policies on trade, industry and technology

A. Overview of policies

1. Trade policies

32. Trade policy measures affect imports and exports of goods, and come in the form of changed tariff rates or other duties, quantitative restrictions including bans, customs procedures, taxes and a whole array of other, non-tariff, measures. Their prominent feature is the ability to discriminate between different markets, products and services.

33. Historically, countries in the region have adopted different trade policies, which fostered the development of particular sectors and the relevant technologies in those sectors. As shown in table 2, these policies have evolved over the past several decades, starting with import substitution, which has evolved into export orientation. Export orientation normally begins with assembly or original equipment manufacturing as well as light industries, and over time the value added of exports increases. Often, export-oriented policies ran parallel to import-substitution policies, as protection was removed only gradually.

Table 2
Shifting of trade and industrial policies in selected economies in Asia

Indonesia	**1948–1966:** Economic nationalism; nationalization of Dutch enterprises	**1967–1973:** Some trade liberalization	**1974–1981:** Oil and commodity boom	**1986 onward:** Gradual trade liberalization and export promotion
Republic of Korea	**1961–1973:** Initial export take-off	**1973–1979:** Heavy and chemical industry drive: selective promotion	**1980–1990:** Gradual trade liberalization and move to less selectivity	**1990 onward:** Trade liberalization and high-technology exports
Malaysia	**1950–1970:** Natural-resource-based exports	**1971–1985:** Import substitution and export promotion through export processing zones	**1986 onward:** Gradual trade liberalization and export promotion	
Taiwan Province of China	**1953–1957:** Import substitution	**1958–1972:** Export promotion	**1973–1976:** Industrial consolidation	**1981 onward:** High-tech industrialization
Thailand	**1955–1970:** Natural-resource-based exports	**1971–1980:** Import substitution	**1980 onward:** Trade liberalization and export promotion	
Singapore	**1959–1964:** Labour-intensive import substitution	**1967–1973:** Labour-intensive export promotion	**1973–1984:** Upgrading export structure	**1985 onward:** Export promotion of high-tech and services
Japan	**1950–1958:** Import substitution	**1959 onward:** Export-oriented trade and foreign exchange	**1967 onward:** Liberalization	**Mid-1980s:** Deregulation

Philippines	**1950 onwards:** Import substitution	**1967–1973:** Continued import substitution	**1980s onward:** Liberalization (political stability)	**1990s onward:** Continued liberalization (strengthened political stability)
Hong Kong, China	**1950 onward:** Export orientation (laissez-faire, education, infrastructure and institutional support)	**1979 onward:** Improved institutional support for industry		**1990s onward:** Upgraded support for technology
China	**1965–1976:** Defence/industry (heavy industrialization)	**1977–1978:** Plant import	**1980s onward:** Coastline liberalization (light industries)	**1990s onward:** High-technology infrastructure

Source: Adapted from John Weiss, "Export growth and industrial policy: lessons from the East Asian Miracle experience", ADB Institute Discussion Paper, No. 26 (Tokyo, Asian Development Bank, 2005); and *Industrial policy and the WTO* (United Nations publication, Sales No. E.00.II.D.26).

34. The 1980s saw a gradual trade liberalization. As of June 2018, 262 preferential trade agreements that had at least one member from the Asia-Pacific region were in force, had been signed or were under negotiation.[16] Despite this, various forms of trade protectionism still exist today. Measures both to restrict and liberalize trade have been applied around the world, including by the countries in the region. For example, between October 2015 and May 2017, 256 trade-restrictive measures were introduced at the global level, 27 per cent of which by Asia-Pacific economies.[17]

2. Industrial policies

35. Industrial policy, in general, refers to any type of selective intervention that attempts to alter the structure of production towards sectors that are expected to offer better prospects for economic growth than would occur in the absence of such intervention, in the market equilibrium.[18] In a broad sense, industrial policies do not have to be written down or publicized. Whenever a Government consciously favours certain economic activities over others, it can be treated as the implementation of industrial policy.[19]

36. Several countries in the region have adopted industrial policies to achieve economic development. For instance, between the 1960s and 1980s, the Republic of Korea maintained an outward-oriented, bottom-up and integrated approach to industrial policy. The Government and chaebols[20]

[16] See www.unescap.org/content/aptiad.

[17] For further information, see *Asia-Pacific Trade and Investment Report 2017: Channelling Trade and Investment into Sustainable Development* (United Nations publication, Sales No. E.17.II.F.22).

[18] Howard Pack and Kamal Saggi, "Is there a case for industrial policy? A critical survey", *World Bank Research Observer*, vol. 21, No. 2 (September 2006).

[19] Dani Rodrik, "Industrial policy for the twenty-first century", paper prepared for UNIDO, Cambridge, Massachusetts, 2004.

[20] A chaebol is a family-run conglomerate in the Republic of Korea. Such groups have been at the heart of its rapid industrial development over many years and tower over almost every area of business. For further information, see http://lexicon.ft.com/Term?term=chaebol.

systematically studied what had to be done to fill the missing links in the domestic value chain and move up the quality ladder, through technology acquisition, human resources development and construction of optimal-scale plants aimed for the global market. As the capacity of the private sector increased and sector-targeting became a more difficult proposition, the Republic of Korea shifted to a more sector-neutral approach, which provided support for industry rationalization and research and development regardless of sector.[21]

37. Evolution of the industrial revolution can also be observed in China. The National Medium- and Long-term Programme for Science and Technology Development (2006–2020) identifies 402 core technologies, ranging from pharmaceuticals to integrated circuits, for prioritized development.[22] Today, arguably, the most important industrial policy in China is the Made in China 2025 plan, and the implementation of subsequent supportive policy measures, which are focused on indigenous innovation and upgrading of manufacturing capabilities.[23]

3. Science, technology and innovation policies

38. National science, technology and innovation policies serve several functions. First, they articulate the Government's vision regarding the contribution of science, technology and innovation to the country's social and economic development. Second, they set priorities for public investment in science, technology and innovation and identify the focus of government reforms. Third, the development of these strategies can engage stakeholders ranging from the research community, funding agencies, business and civil society to regional and local governments in policymaking and implementation. In some cases, national strategies outline the specific policy instruments to be used to meet a set of goals or objectives. In others, they serve as visionary guideposts for various stakeholders.[24]

39. In Thailand, the conceptual framework of the National Science, Technology and Innovation Policy and Plan 2012–2021 identifies challenging issues impacting the development of science, technology and innovation to better serve the needs of the economy and society of Thailand throughout the next decade.[25]

4. Policies today are often bound by international trade rules

40. Evidence shows that policies related to industry, trade and science, technology and innovation have been widely used in practice, not only by countries in the region, but also by traditionally advanced economies. For instance, a study shows that discrimination across sectors, against foreign commercial interests and between domestic firms have been important features of policy choice by large economies such as Brazil, China, the European Union, Japan, the Republic of Korea, the Russian Federation and the United

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[21] Joseph E. Stiglitz, Justin Yifu Lin and Célestin Monga, "The rejuvenation of industrial policy", Policy Research Working Paper, No. 6628 (Washington, D.C., World Bank, 2013).

[22] Reggie Lai and Lingling Deng, "China's industrial policy and its implications for foreign manufacturers", American Chamber of Commerce in Shanghai, 9 November 2017.

[23] See http://english.gov.cn/2016special/madeinchina2025.

[24] Organization for Economic Cooperation and Development, "National strategies for STI", *OECD Science, Technology and Innovation Outlook 2016* (Paris, 2016).

[25] See www.sti.or.th/encontent.php?content_type=3.

States of America since the beginning of the global financial crisis in 2007, although resort to them by these countries differed.[26]

41. In an era of free trade, policy measures widely used three or four decades ago may not be valid according to international trade rules. Under the framework of free trade agreements (multilateral, regional and bilateral), some selective interventions that affect trade by protecting domestic markets or promoting exports are prohibited or restricted under multilateral trade agreements signed under the auspices of the World Trade Organization (WTO). Among them are restrictions on the use of export subsidies, prohibition of performance requirements such as domestic content requirements, and limits on the use of quantitative restrictions on imports. There are, however, (temporary) exceptions to the above rules, such as special and differential treatment, that allow developing countries to retain or use some policy instruments whose use would otherwise be forbidden or restricted.[27]

42. Of the 53 member States of the Economic and Social Commission for Asia and the Pacific (ESCAP), 40 are WTO members and five are in the process of accession to WTO, meaning that 85 per cent of ESCAP member States are or will be subject to WTO trade disciplines.[28]

43. Technology transfer and innovation are covered by several WTO agreements, such as those on subsidies, intellectual property, services and technical barriers to trade, as shown in table 3.

Table 3
Coverage of policies related to technology and innovation in the agreements of the World Trade Organization

Policy/measure	*Relevant WTO agreement*
Domestic support and incentives for research and development (for example, subsidies)	Agreement on Subsidies and Countervailing Measures Agreement on Agriculture
Protection and enforcement of intellectual property rights	Agreement on Trade-Related Aspects of Intellectual Property Rights
Commercialization of publicly funded research	Agreement on Trade-Related Aspects of Intellectual Property Rights
Transfer of technology and know-how	General Agreement on Trade in Services Agreement on Trade-Related Investment Measures Agreement on Trade-Related Aspects of Intellectual Property Rights

[26] Vinod K. Aggarwal and Simon J. Evenett, "Industrial policy choice during the crisis era", *Oxford Review of Economic Policy*, vol. 28, No. 2 (July 2012).

[27] *Economic Development in Africa Report 2014: Catalysing Investment for Transformative Growth in Africa.* (United Nations publication, Sales No. E.14.II.D.2).

[28] See www.unescap.org/sites/default/files/ESCAP%20members%20and%20associate%20members%20and%20status%20of%20their%20membership%20in%20WTO-1%20May%202017.pdf.

Policy/measure	*Relevant WTO agreement*
Government procurement	General Agreement on Tariffs and Trade
	Agreement on Trade-Related Investment Measures
	Agreement on Government Procurement
Technical standards	General Agreement on Tariffs and Trade
	Agreement on Technical Barriers to Trade
	Agreement on the Application of Sanitary and Phytosanitary Measures
Competition policy	Agreement on Trade-Related Aspects of Intellectual Property Rights
	Agreement on Trade-Related Investment Measures
Policy/regulatory frameworks and general infrastructure	Aid for Trade initiative

Source: John M. Curtis, *Trade and Innovation: Policy Options for a New Innovation Landscape* (Geneva, International Centre for Trade and Sustainable Development and World Economic Forum, 2016).

B. Policy priorities

44. Developing countries may have the most to gain from applying some level of industrial policy appropriate to their strategic development and science, technology and innovation policy aspirations. This is because development involves structural transformation and diversification processes which create rather than exploit existing comparative advantage.[29]

45. Countries in the region differ in terms of economic structure, national and financial resources and access to international market, among other differences. A one-size-fits-all development strategy is probably unrealistic. Notwithstanding the differences, the following recommendations may be regarded as common denominators.

1. Aligning all policies with national strategy

46. Despite the importance of policies related to industry, trade and science, technology and innovation, policymakers should never lose sight of the fact that these policies should be designed and implemented within a much broader framework of national strategy. Policy should be geared towards supporting the country in acquiring, absorbing and upgrading technologies, enhancing productivity and moving up the ladder of global value chains, rather than answering rent-seeking lobbies.

47. Historically, several countries in the region have successfully adopted policies to achieve technological upgrading and economic development. As shown in table 2, the industrial and trade policies adopted by 10 economies in the region between the 1950s and the 1990s were geared to support and spur technological learning and upgrading and support a national strategic plan of economic development. The export of primary products was vitally important for the economies in the table in the 1960s. Between the 1960s and the 1980s, exports of textiles, clothing and footwear from these economies were initially important and subsequently declined in relative terms. In the 1980s, several of these economies substantially increased their exports of more capital- and

[29] Rodrik, "Industrial policy".

technology-intensive goods, such as electrical machinery, chemicals and pharmaceuticals, and computer and communications equipment. Some of these goods embodied advanced, international best-practice technology. In the 1990s, several more countries moved to more technologically-intensive sectors, such as computers and communications equipment. These two categories accounted for 24 per cent of total non-oil exports in Malaysia and for 14 per cent in Thailand in 1994.[30]

48. Today, countries in the region continue to adopt policies to achieve a national strategy. In the Philippines, the Comprehensive National Industrial Strategy aims to link and integrate manufacturing, agriculture and services, address supply-chain gaps and deepen industry participation in global value chains. Strategic action includes, among others, innovation and research and development activities and green industries.[31]

49. One strategy is to develop more generic technologies which have the potential to bring benefits to multiple sectors. For instance, according to the Fifth Science and Technology Basic Plan of Japan, the Government will further promote the development of technology for the Internet of things, big data analytics, high-speed processing devices, artificial intelligence, networking, edge computing and cybersecurity, which are seen as the fundamental technologies necessary to build the service platform for a so-called super-smart society. The Government will also promote the development of such technologies as those related to robotics, sensors and human interface, which are seen as the fundamental technologies that are the country's strengths and which form the core of new value creation.[32]

50. Alternatively, the adoption of advanced technologies may start with a small group of firms, sectors or geographic areas, taking possible scalability and wide technology diffusion into consideration. This strategy may be particularly suitable for small economies with limited financial and human resources to adopt technologies for all sectors. Even for relatively large economies, this strategy enables the country to go through a process of learning and, probably, trial and error. An example in this respect is the strategy in Indonesia of using frontier technology for productivity enhancement, in five main sectors in particular: food and beverage, textiles and clothing, automotive, electronics and chemical.[33]

2. Enhancing institutional cooperation

51. Different policies are formulated by different ministries and departments. Trade policies are most likely formulated by the ministry in charge of trade and commerce, industrial policies by the ministry of industry and enterprise, and science, technology and innovation by the ministry of

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[30] Weiss, "Export growth and industrial policy".

[31] For further information, see http://industry.gov.ph/comprehensive-national-industrial-strategy.

[32] See www.tillvaxtanalys.se/download/18.36a7c6515478fc61a479ce2/1463050071286/Japans%20fem%C3%A5rsplan.pdf.

[33] Bambang Brodjonegoro, Minister of National Development Planning and Head of the National Development Planning Agency of Indonesia, "Tapping technology advancement to achieving SDGs", presentation to the Commission at its seventy-fourth session, Bangkok, 16 May 2018. Available at www.unescap.org/commission/74/files/16may-am-Mr_Bambang_Brodjonegoro-ppt.pdf.

science and education. As such, policies covering technology and innovation may be fragmented.

52. To ensure that the policies are consistent and mutually strengthening, it is essential to establish a coordinating mechanism between policymakers and representatives of funding agencies, education and industry, in an effort to synchronize institutional action to better match the strategy related to science, technology and innovation and development. This institutional arrangement also requires awareness of trade policies and communication and capacity-building in relation to them. For instance, if the policies on science, technology and innovation are prepared by the ministry of science, its staff may not be aware of the trade rules on technology transfer. Support from the ministry in charge of trade and commerce is therefore essential.

53. Countries in the region have adopted different approaches in institutional cooperation. In Singapore, the innovation ecosystem comprises various ministries and research and development funding bodies and performers. At the top is the Research, Innovation and Enterprise Council, chaired by the Prime Minister, which oversees the long-term strategy to transform Singapore into a knowledge-based society, with strong capabilities in research and technology. The Council is supported by the National Research Foundation Board, which is responsible for the formulation of five-year plans and policies to grow the country's research capability, support economic growth and meet future national challenges.[34]

54. The Malaysian Industry-Government Group for High Technology was established on 22 February 1993 as the technology think tank under the purview of the Prime Minister's Department. It is governed by a board of directors and helmed through the joint chairmanship of a prominent private sector personality and the Science Advisor to the Prime Minister. The Group emphasizes market intelligence initiatives using foresight practices and methodology to identify technology and business opportunities. It is built on the strength of public-private partnership with members representing both local and international organizations.[35]

3. Paying equal attention to technology commercialization and research and development

55. Traditional thinking of innovation as a linear process from research and development, scientific breakthrough and intervention to commercialization of technologies explains why countries often support higher education and research and development. However, since the early 1980s, the theory of the national innovation system has increasingly gained recognition. It includes the argument that innovation often takes place in enterprises and firms; transformation from a breakthrough in a laboratory to commercial viability is rarely automatic, and innovation can also be unpredictable. Therefore, to effectively encourage innovation, a country should facilitate the development of a national environment that is conducive to innovation.[36]

56. While developing a national innovation system may be a long-term goal, policies can always be guided to support firms and enterprises to innovate. Figure II shows four groups of firms according to their awareness of and absorptive capacity for technology and their desire to innovate. At the

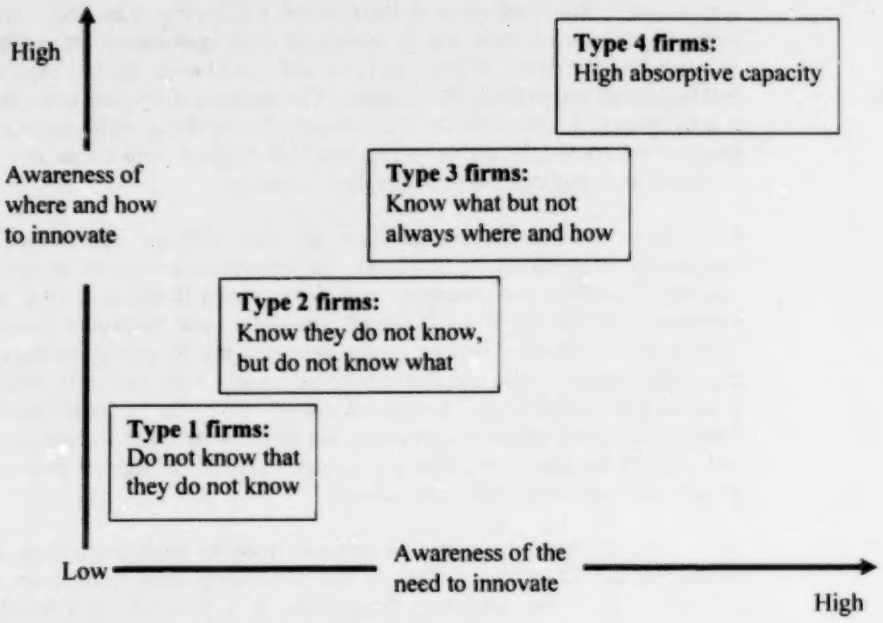
[34] See www.nrf.gov.sg/about-nrf/rie-ecosystem.

[35] For further information, see www.might.org.my/about-us.

[36] Chris Freeman, "The 'national system of innovation' in historical perspective", *Cambridge Journal of Economics*, vol. 19, No. 1 (February 1995).

lowest level are firms with no capacity for technological change and that do not feel any need for change.

Figure II
Classification of firms by their technological capability and motivation to change


High
Awareness of where and how to innovate
Type 4 firms: High absorptive capacity
Type 3 firms: Know what but not always where and how
Type 2 firms: Know they do not know, but do not know what
Type 1 firms: Do not know that they do not know
Low
Awareness of the need to innovate
High

Source: Based on World Bank, "Part A: firm-level innovation in the Korean economy", in *Korea: Technology, Skills and Internet Services in Korea –Moving Towards a Knowledge-based Economy* (Washington, D.C., 2003). Available at https://openknowledge.worldbank.org/bitstream/handle/10986/14615/multi0page.pdf?sequence=1.

Note: The study, published in 2003, focused on firms in the Republic of Korea. However, the discussion is still relevant to many firms in developing countries in the region.

57. Policies in this case should focus on moving firms up the ladder by addressing two dimensions, as shown in figure II. First, through policies, firms should be encouraged to improve their capacity to absorb technologies. In particular, policies related to trade and foreign direct investment may help firms gain access to foreign technology. Second, policies should be used to improve the internal motivation of firms to change. Through the policies, an environment needs to be created that is conducive to "healthy" market competition, so that firms and entrepreneurs will then choose to innovate and absorb appropriate technologies based on their reading of their markets.

58. In Singapore, innovation and enterprise, academic research and manpower are identified as three cross-cutting programmes to achieve its Research, Innovation and Enterprise 2020 Plan.[37] In Kazakhstan, innovation and technology have been fostered in the Technology Commercialization

[37] See www.nrf.gov.sg/rie2020.

Project, which is being implemented by the Ministry of Education and Science of Kazakhstan and assisted by the World Bank.[38]

4. Embracing digital trade and the information economy

59. As discussed in sections II and III, the rapid development of technology, especially ICT, has constantly changed the dynamism between technology and trade. Electronic commerce is an important example of such reliance on trade, transforming the way in which traditional trade is conducted and stimulating trade growth.

60. Domestic policies need to address the new business opportunities and potential challenges of electronic commerce and digital trade. On the one hand, policies must support micro- and small enterprises, individuals and rural smallholders in participating in electronic commerce so that they can access larger domestic and international markets, thereby promoting inclusive development. On the other hand, policies must also address the adverse effects. For example, the competition created by e-commerce may put substantial pressure on traditional bricks-and-mortar small-scale retailers and local suppliers (such as local producers and vendors), and in some cases may force them out of the market. Policies must be introduced to address the challenges of job losses due to the digital economy.

61. At the regional level, collaboration among countries provides another dimension of exploring the benefits of technology. For instance, the Framework Agreement on Facilitation of Cross-border Paperless Trade in Asia and the Pacific, as mentioned earlier, features modules on capacity-building and technical assistance, which enable all countries in the region, including the least developed countries, to benefit from cross-border paperless trade.

62. In a broader sense, the rapid development of ICT and penetration of the Internet mean that most, if not all, countries in the region are moving towards digital trade or an information economy, although the pace in this process differs. Among multidimensional issues to be addressed through policies, personal data protection has been one of the most important topics for discussion. The entry into application of the General Data Protection Regulation in May 2018, which constitutes a single set of data protection rules for all companies operating in the European Union, certainly has profound implications for policymaking in the region.[39]

5. Playing by the trade rules

63. Developing countries operate today in a global policy environment that is very different to that of two or three decades ago. In particular, there has been a tendency to limit national economic policies through multilateral, regional or bilateral agreements, imposing restrictions on the ability of developing countries to introduce certain types of policies related to industry, trade and science, technology and innovation. For instance, export subsidies may not be a valid policy measure under a free trade agreement.

64. Accordingly, whenever policies related to industry, trade and science, technology and innovation are developed and implemented, it is important to

[38] World Bank, "Technology commercialization for an innovative economy in Kazakhstan", 23 January 2014.

[39] For further information, see https://ec.europa.eu/commission/priorities/justice-and-fundamental-rights/data-protection/2018-reform-eu-data-protection-rules_en.

ensure that these policies are compatible with any trade agreements to which a country is party.

65. On the other hand, the least developed countries should explore the potential opportunities brought about by international trade agreements. For instance, article 66 (2) of the Agreement on Trade-related Aspects of Intellectual Property Rights states that developed country members should provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country members in order to enable them to create a sound and viable technological base.[40]

V. Conclusion

66. In 1955, Nobel laureate Arthur Lewis pointed out that no country had made economic progress without positive stimulus from intelligent Governments.[41] His statement has been echoed by the fact that over the past several decades, a number of countries in the region – such as China, Japan and the Republic of Korea – have successfully adopted policies related to industry, trade and science, technology and innovation in the process of catching up with other countries.

67. Today, Governments and policymakers still have an important role to play in the process of economic development. In an era of free trade and international competition, technological upgrading and innovation constitute an essential ladder for developing countries in the region to develop their economies and climb up the global value chains. Relying purely on the market will probably lock developing countries, especially the least developed countries, into their areas of comparative advantage, such as labour-intensive and low-technology industries, and exacerbate their marginalization in the international market.

68. A holistic policy approach needs to be adopted by the countries in the region to address the challenges of economic development and technological upgrading. Government policies should aim to create an enabling environment so that the market encourages innovation. This enabling environment should also facilitate collaboration between multiple stakeholders – such as universities, research institutions, firms and enterprises, international companies and multinational corporations – for the purposes of innovation.

69. Countries in the region need to be proactive in adopting new digital technologies such as big data and e-commerce. While debates on the pros and cons of these technologies will continue, in reality there is no turning back; these technologies continue to penetrate every country. Indeed, countries in the region should take advantage of the new opportunities for business and trade that are generated by these technologies. On the other hand, the diffusion of these technologies imposes new challenges on rules and regulations. Some emerging issues, such as personal data protection, are receiving profound attention internationally, especially in the light of the entry into application of the General Data Protection Regulation in May 2018. Countries in the region need to make or adjust policies to cope with the new challenges related to areas

[40] See *Legal Instruments Embodying the Results of the Uruguay Round of Multilateral Trade Negotiations, done at Marrakesh on 15 April 1994* (GATT secretariat publication, Sales No. GATT/1994–7).

[41] W. Arthur Lewis, *The Theory of Economic Growth* (London, Allen and Unwin, 1955).

such as cross-border data flow, intellectual property, privacy and cybersecurity.

VI. Issues for the consideration by the Committee

70. Innovation growth can be path-dependent, and solutions for enhancing innovation can vary from country to country. Nevertheless, as discussed in the present document, there are also common issues related to trade and technology in the region. Successful experiences and lessons learned in leveraging technology and trade for development should be shared among countries in the region. In this connection, the Committee on Information and Communications Technology, Science, Technology and Innovation may wish to debate the following questions, ideally by reflecting on the experiences of member States:

(a) What are the drivers of technological change and the catch-up process in developing countries?

(b) How can developing countries successfully build up their own modern industries through indigenous innovation and foreign technologies?

(c) How can developing countries take advantage of digital trade and the digital economy?

(d) What policy interventions in the areas of trade, industry and science, technology and innovation have proved effective in achieving their goals?

71. The Committee may wish to discuss other issues contained in the present document. Furthermore, the Committee may wish to provide guidance to the secretariat on research topics that it should undertake and on other types of support, such as technical assistance or capacity-building, that it should provide.